Changes to the European Resuscitation Council cardiac arrest management guidelines – a commentary

DILSHAN ARAWWAWALA, STEPHEN BRETT

Abstract

The European Resuscitation Council guidelines for the management of cardiac arrest have been updated. The following commentary discusses the major changes, the evidence on which they are based and the practical issues of their introduction.

Key words: resuscitation, guidelines, European Resuscitation Council, cardiac arrest.

Br J Cardiol 2006;**13**:425–9

Introduction

The updated European Resuscitation Council guidelines are derived from treatment recommendations made by the International Liaison Committee on Resuscitation (ILCOR) following the 2005 International consensus conference on cardiopulmonary resuscitation and emergency cardiovascular care science (Dallas, North America).[1,2] The process involved 281 experts in the field of resuscitation and emergency medicine reviewing current scientific evidence.[3,4] Findings were presented at the conference and, where possible, treatment recommendations were made.

In the updated guidelines, many fundamental changes have been made to 'basic life support' and 'advanced life support' for adults (table 1). Sudden cardiac arrest affects around 700,000 people in Europe each year and cardiovascular mortality accounts for 40% of all-cause mortality.[5] Despite widespread training of healthcare professionals and laypersons, survival rates remain modest at best. One European study identified only 16.5% of in-hospital cardiac arrests survive to hospital discharge with a mortality rate significantly higher than the general population for the subsequent two years.[6] Data from America gives an out-of-hospital (OOH) cardiac arrest survival of between 3–26%.[7,8]

Department of Intensive Care Medicine, Hammersmith Hospital, Du Cane Road, London, W12 OHS.
Dilshan Arawwawala, Specialist Registrar in Anaesthesia and Intensive Care Medicine
Stephen Brett, Consultant in Intensive Care Medicine
Correspondence to: Dr D Arawwawala
(email: darawwawala@googlemail.com)

Time from arrest to commencement of CPR

"Lay people should be taught to begin cardio-pulmonary resuscitation (CPR) if the victim is unconscious and not breathing normally."

An emphasis of the recommendations is minimising the time spent assessing the patient as this often yields inaccurate results and prolongs the time to cardio-pulmonary resuscitation (CPR). Studies have shown a lack of accuracy and prolonged time periods required in carotid pulse and breathing assessment by health care professionals/medical students and lay rescuers.[9-11] Although the way in which the assessments were made was not consistent, the conclusions are similar. One observational study identified 56% of OOH cardiac arrest patients had ventricular fibrillation (VF) or ventricular tachycardia (VT) as their initial rhythm.[12] In the absence of immediate CPR, this rapidly degenerated into asystole with a subsequent reduction in the chance of successful resuscitation.[13]

A reduced rate of return of spontaneous circulation (ROSC) with increased duration of hands-off time has been shown in an animal study.[14] In a prospective observational study, 156 human victims with VF had their ECG signal preceding shocks analysed and this was compared to rates of ROSC. The investigators found that waveforms with a high or median probability of ROSC deteriorated with extending lengths of hands-off time.[15] This single-centre study would benefit from further validation. Studies from America and Europe also show mortality increases if CPR and defibrillation are delayed.[16-20] The data from these studies are mainly from registries, with statistical analysis of times for each stage in the resuscitation process. Crucially, some of these times are estimated from bystander information or given an allocated time, e.g. time from ambulance to rhythm recognition. This is obviously highly variable and dependant on the circumstances.

Although the evidence available is mainly from retrospective analysis, it seems a logical conclusion that the longer a person is left without cardio-respiratory aide, the less likely the chances of survival.

Commencement of CPR

"It is recommended that in adults, CPR should start with compressions rather than initial ventilation."

The evidence behind this statement is based on an animal study of electrically-induced VF in 30 anaesthetised and intubated swine. Ventilation and oxygenation at five minutes post-arrest was significantly reduced but still substantial in swine receiving continuous chest compressions only. Swine receiving standard

Table 1. Summary of important changes for adults in the guidelines

European Resuscitation Guidelines 2005	European Resuscitation Guidelines 2000
Basic life support **For lay rescuers:** • Commence CPR if a victim is unresponsive and not breathing normally. If you have any doubt whether breathing is normal, act as if it is not normal • Place hands on the centre of the chest • The ratio of compressions to ventilations is 30:2 • 30 compressions should be given immediately after cardiac arrest is established	**Basic life support** **For lay rescuers:** • The decision to start CPR is made if a victim is unresponsive and not breathing • Use the 'rib margin' method to place heel of one hand on the middle of the lower half of breastbone • The ratio of compressions to ventilations is 15:2 • Give two effective breaths. Check for a pulse if trained to do so. Take no more than 10 seconds. If no signs of a circulation or uncertain, commence chest compressions
Advanced life support • When an out-of-hospital cardiac arrest is attended, but unwitnessed, by healthcare professionals equipped with manual defibrillators, give CPR for two minutes before defibrillation. Do not delay defibrillation for in-hospital arrest, or if an out-of-hospital arrest is witnessed by a healthcare professional • Treat VF/VT with a single shock, followed by immediate resumption of CPR. Do not reassess the rhythm or feel for a pulse. After two minutes of CPR, check the rhythm • The recommended initial energy for biphasic defibrillators is 150–200 J. Give second and subsequent shocks at 150–360 J. The recommended energy when using a monophasic defibrillator is 360 J for both the initial and subsequent shocks	**Advanced life support** • Basic life support should be started if there is any delay in obtaining a defibrillator, but must not delay shock delivery • Up to three shocks are given initially. The carotid pulse should be palpated if the waveform changes to one capable of providing a cardiac output • No recommendation for biphasic defibrillator energy levels When using a monophasic defibrillator, the initial two shocks are given at 200 J with subsequent shocks at 360 J. If VF/VT recurs the algorithm is applied from the beginning

Key: CPR = cardio-pulmonary resuscitation; VF = ventricular fibrillation; VT = ventricular tachycardia

chest compression and ventilation (at a ratio of 15:2) had a significant reduction in coronary perfusion pressure and the absolute number of chest compressions given. This was reflected in 24-hour survival and neurological outcome results with far better outcome in those animals receiving chest compressions only.[21] As mouth-to-mouth ventilation remains unattractive for many people for a variety of reasons, it seems a plausible change to the treatment recommendations.

Hand position

"Each time compressions are resumed, the rescuer should place his hands without delay in the centre of the chest"

Although not specifically recommended, the new hand position is seen as a way of reducing delay to commencement of compressions. One study of 60 volunteers showed no improvement in accuracy or retention of information with the new position compared to old, however, they did show a significant reduction in time from end of ventilation to start of compressions (2.9 *vs.* 4.43 seconds).[22] The new position will be easier to teach to all rescuers and may increase the time spent providing chest compressions.

Chest compressions

"…recommend an immediate shock, as soon as an AED is available…We recommend shock delivery as soon as possible following in-hospital cardiac arrest"

In the absence of immediate defibrillation, chest compressions prior to defibrillation may improve survival. A single, blinded, randomised, controlled study in Norway of 200 patients with proven ventricular fibrillation showed CPR for five minutes improved rates of ROSC and survival at hospital discharge and at one year. This was only significant in victims with greater than five minutes from collapse to first defibrillation.[23] An Australian, single, blinded, randomised study of 256 patients showed no improvement in survival with CPR for 90 seconds prior to defibrillation.[24] Unfortunately, the periods of CPR are different for the two studies. Once a defibrillator is available, lay people are recommended to perform immediate defibrillation at an unwitnessed arrest. Medical personnel, however, are advised to assess each case. If there has been a prolonged time period without CPR, then it would not be unreasonable for CPR to be performed prior to defibrillation. This demonstrates the lack of evidence available to provide further clarity on this topic. The Committee has thus opted for the safest approach of recommending immediate shock delivery to minimise confusion and time spent making such decisions.

Ventilation to compression ratio

"A ratio of 30 compressions to two ventilations is recommended for the single rescuer attempting resuscitation on an adult"

Rescue breaths have been shown to have adverse haemodynamic effects. The evidence for this is from swine studies which show reduced coronary perfusion pressure (CPP), number of

Table 2. Articles with their designated level of evidence and grading of recommendation based on Scottish Intercollegiate Guidelines Network SIGN.[37] Level A is the highest level of recommendation

Recommendation	Author	Year	Subject	Study design	Number	Level of evidence	Grade of recommendation
Commencement of CPR if not breathing normally and unresponsive	Larsen	1993	human	retrospective cohort	1,667	2	C
	Valenzuela	1997	human	retrospective cohort	1,872	2	
	Holmberg	1998	human	retrospective cohort	10,966	2	
	Holmberg	2001	human	prospective cohort	9,877	2+	
	Waalewijn	2001	human	prospective cohort	1,030	2+	
CPR prior to defibrillation	Wik	2003	human	R/C	200	1+	No recommendation
	Jacobs	2005	human	R/C	265	1+	
Ventilation:compression ratio	Berg	2001	pigs	series	14	3	D
	Babbs	2002	mathematical			4	
	Sanders	2002	pigs	series	40	2+	
	Kern	2002	pigs	series	30	2	
	Dorph	2003	pigs	series	9	2	
	Kern	2004	pigs	series	12	2+	
Defibrillation	Schneider	2000	human	RCT	120	1+	B
	van Alem	2003	human	prospective cohort	184	2+	
	van Alem	2003	human	RCT	120	1+	
	Valenzuela	2005	human	retrospective cohort	61	2	

chest compressions, and left ventricular performance during periods of ventilation when compared to chest compressions alone or higher compression rates.[21,25-28] The evidence for this is equivocal as results defined by ROSC and neurological outcome do not consistently favour any one approach.[21,25-27,28] Kern *et al*. suggested improvement in these outcomes with continuous compressions only compared to standard ratios.[21] However, the same group showed, in a more recent paper, no significant difference in 24-hour survival between ventilated and non-ventilated animals and a better 24-hour neurological outcome in those receiving some ventilation.[27] This may be due to the small numbers of animals used in the studies.

Others have shown arterial oxygen saturation and CPP depend on the compression: ventilation ratio used. More compressions and improved CPP was obtained with higher compression: ventilation ratios at the expense of lower arterial oxygen saturations.[29] A 30:2 ratio provided an earlier ROSC and far superior arterial oxygen saturations compared to continuous compressions alone.

Observational studies show both healthcare and lay rescuers tend to hyperventilate victims.[26] An observational study of CPR using ventilation at a ratio of 15:2 compressions showed ventilation can take up to 16 seconds of each minute.[30] This reduces the time for compressions and leads to a reduced mean CPP. The optimal ratio of chest compressions to rescue breaths for humans is unknown. A mathematical model has suggested an optimal ratio for oxygen delivery of 30–70:2.[31] It is possible that an alternative ventilation rate may be better. The newly recommended ratio of 30:2 is from animal work only.[29]

Based on small studies of swine, observational and mathematical studies, the conclusion appears to be that some ventilation is required for better neurological outcomes, however, the optimal ratio is still not known and will be a compromise between oxygen delivery and CPP. Again, the committee point out the lack of human studies and the limitations of animal work. Their aim appears to provide some ventilation whilst minimising interruptions to chest compressions.

Defibrillation

"Immediately after giving a single shock and without reassessing the rhythm or feeling for a pulse, resume CPR…..even if the defibrillation attempt is successful in restoring a perfusing rhythm, it is very rare for a pulse to be palpable…"

There are no studies comparing a one-shock strategy to a three-shock strategy. The rationale for change is partly based on the previously mentioned animal and human observational studies showing the importance of continuous chest compressions on improving physiological parameters and the chance of survival, especially when time to first shock is greater than five minutes.[23] A model of VF described by Weisfeldt and Becker may also help explain the change. They described three phases to ventricular fibrillation: an electrical phase (lasting up to four minutes) during which time immediate defibrillation will be successful, followed by a circulatory phase (four to 10 minutes) where providing an artificial circulation prior to defibrillation improves survival, and then a metabolic phase (greater than 10 minutes) after which the effectiveness of defibrillation and CPR rapidly decreases.[32] Most OOH cardiac arrest patients are within the second phase. Eftestel *et al*. have shown a reduction in defibrillation success with increasing periods of interruption to chest compressions.[15]

Observational studies have shown that significant delays for

pulse assessment, rhythm interpretation and for CPR commencement can occur with OOH cardiac arrests using AEDS (automated external defibrillators). A retrospective, observational study of 61 cases from a 10-year period by Valenzuela *et al.* showed chest compressions occurred, on average, for only 43% of the initial resuscitation period. No initial shock sequence resulted in a rhythm capable of providing an adequate cardiac output and three shocks took 1 minute 44 seconds.[33] These findings are similar to an earlier prospective observational study looking at a two-year period of OOH cardiac arrests attended by police and firemen using AEDs. Compressions occurred for an average 37% of the initial resuscitation period, with 40% of 'non-compression time' being due to AED rhythm assessment, voice prompts and time for pulse checks. No palpable pulse was felt following successful defibrillation leading to a conclusion that if a rhythm ordinarily capable of providing a perfusing circulation returns, adequate body perfusion rarely does immediately.[34]

Human, prospective, randomised studies have shown greater defibrillation success with biphasic defibrillators compared to monophasic defibrillators.[35,36] The recommended energy level is derived from studies of efficacy. Monophasic waveforms produce a 200 J first-shock efficacy of 56–91% compared to biphasic waveforms which produce a 150–200 J first-shock efficacy of 86–98%. Monophasic defibrillators are now being phased out in favour of biphasic models. If an initial successful shock does not return a palpable output, it usually means the heart requires better perfusion. This can only be achieved with basic life support.

Thus, there are several logically defendable reasons, backed by animal and observational studies, for a one-shock approach, coupled with the removal of unnecessary assessment checks and continuous chest compressions for the first two minutes post-defibrillation.

Practical problems

These updated guidelines will hopefully lead to improved survival but since they include significant changes, there will be benefits as well as problems with their introduction. An evidence-based approach adds weight to the methodology being taught. The emphasis on early CPR will hopefully lead to a focus on good-quality, early, chest compressions rather than the diagnosis of cardiac arrest. The benefit of doubt will now be in favour of the arrested patient. Defibrillation will be more straightforward with only one energy level, losing the confusion of restarting algorithms with rhythm changes.

The use of a 30 compressions:2 ventilations ratio may raise problems with achieving continuous and effective compressions. Frequent changes of personnel may be possible within a hospital setting but for the lone rescuer, fatigue may occur more rapidly. Introducing such dramatic changes will inevitably lead to resuscitation teams consisting of members trained with the old guidelines and some with the new. This may initially lead to confusion and suboptimal resuscitation. This would also apply to the lay rescuer with a newly programmed AED. The shift in emphasis from traditional CPR to cardiac dominated resuscitation, may lead to the loss of the airway specialist from the cardiac arrest team. This may lead to problems when a ROSC is achieved without adequate airway control or ventilation.

The possibility of attempting resuscitation on a patient with adequate cardiac and pulmonary function may potentially occur with the new changes. Whether this has any impact remains to be seen.

The financial implications of widespread introduction are potentially an issue. Re-educating all resuscitators and providing new equipment (e.g. biphasic defibrillators, AEDs) or reprogramming old equipment (AEDs) will take time and money. Since the original guidelines have not been withdrawn, the new ones can be rolled out first by well-organised resuscitation departments. Most manufacturers are now updating and reprogramming machines at modest cost.

Key messages

- Emphasis is now on maintaining coronary perfusion pressure by minimising interruptions to chest compressions from vital sign checks and excessive ventilation
- There have been significant changes to the guidelines for the management of cardiac arrest
- The evidence base is from animal or observational studies, which will not necessarily lead to the anticipated benefit
- Rigorous auditing of the new guidelines is needed

Conclusion

The ILCOR recommended changes to resuscitation guidelines that will hopefully lead to an improvement to ROSC, morbidity and survival statistics. Much of the evidence is animal based or from observational studies. Grading of the evidence identifies nearly all of the recommendations as level C (see above).[37] In other areas of medicine, this would rarely lead to such major changes in practice (table 2). Given the difficulty in producing randomised controlled trials, this is probably the best that can be achieved at present. The extrapolation from animal data to human patients does not necessarily lead to the anticipated benefits. Several important papers are retrospective and derived from the same national registers. This may lead to the repetitive impact of confounding factors and unidentified biases. As these registers span a long period of time, there will have been changes in practice which may also affect the data. Rigorous auditing of the impact of implementation on outcomes is essential to see if the changes that are introduction do, indeed, lead to more favourable results.

Conflict of interest

None declared.

References

1. http://www.erc.edu/
2. European Resuscitation Council. European Resuscitation Council 2005. *Resuscitation* 2005;**67**:S1-S189.
3. Morley P, Zaritsky A. The evidence evaluation process for the 2005 International Consensus on cardiopulmonary resuscitation and emergency cardiovascular care science with treatment recommendations. *Resuscitation* 2005;**67**:167-70.
4. Recommended guidelines for the uniform reporting of data from out of hospital cardiac arrest: the "Utstein style". Prepared by a taskforce of representatives from the European Resuscitation Council, American Heart Association, Heart and Stroke Foundation of Canada, Australian Resuscitation Council. *Resuscitation* 1991;**22**:1-26.
5. Sans S, Kesteloot H, Kromout D. The burden of cardiovascular diseases mortality in Europe. Task Force of the European Society of Cardiology on cardiovascular mortality and morbidity statistics in Europe. *Eur Heart J* 1997;**18**:1231-48.
6. Kalbag A, Kotyra Z, Richards M, Spearpoint K, Brett S. Long term survival and residual hazard after in-hospital cardiac arrest. *Resuscitation* 2006;**1**:79-83.
7. Huikuri HV, Castellanos A, Myerburg MJ. Sudden death due to cardiac arrhythmias. *N Eng J Med* 2001;**345**:1473-82.
8. Zipes DP, Wellenws HJ. Sudden cardiac death. *Circulation* 1998;**98**: 2334-51.
9. Bahr J, Klingler H, Panzer W, Rode H, Kettler D. Skills of lay people in checking the carotid pulse. *Resuscitation* 1997;**35**:23-6.
10. Ruppert M, Reith MW, Widmann JH *et al*. Checking for breathing: evaluation of the diagnostic capability of emergency medical services personnel, physicians, medical students and medical lay persons. *Ann Emerg Med* 1999;**34**:720-9.
11. Perkins GD, Stephenson B, Hulme J, Monsieurs KG. Birmingham assessment of breathing study (BABS). *Resuscitation* 2005;**64**:109-13.
12. Cobb LA, Fahrenbruch CE, Olsufka M, Copass MK. Changing Incidence of out-of hospital ventricular fibrillation 1980-2000. *JAMA* 2002;**288**: 3008-13.
13. Larsen MP, Eisenberg MS, Cummings RO, Hallstrom AP. Predicting survival from out of hospital cardiac arrest. A graphic model. *Ann Emerg Med* 1993;**22**:1652-8.
14. Sato Y, Weil MH, Sun S *et al*. Adverse effects of interrupting precordial compression during cardiopulmonary resuscitation. *Crit Care Med* 1997; **25**:733-6.
15. Eftestel T, Sunde K, Steen PA. Effects of interrupting precordial compressions on the calculated probability of defibrillation success during out of hospital cardiac arrest. *Circulation* 2002;**105**:2270-3.
16. Valenzuela T, Roe D, Cretin S, Spaite DA Larsen M. Estimating the effectiveness of cardiac arrest interventions. *Circulation* 1997;**96**:3308-13.
17. Larsen MP, Eisenberg MS, Cummings RO, Hallstrom AP. Predicting survival from out of hospital cardiac arrest: a graphic model. *Ann Emerg Med* 1993;**22**:1652-8.
18. Holmberg M, Holmberg S, Herlitz J. Factors modifying the effect of bystander cardiopulmonary resuscitation on survival in out of hospital cardiac arrest patients in Sweden. *Eur Heart J* 2001;**22**:511-19.
19. Holmberg M, Holmberg S, Herlitz J, Gardelov B. Survival after cardiac arrest outside hospital in Sweden. Swedish cardiac registry. *Resuscitation* 1998;**36**:29-36.
20. Waalewijn RA, De Vos R, Tijssen JGP, Koster RW. Survival models for out of hospital cardiopulmonary resuscitation from the perspectives of the by-stander, the first responder and the paramedic. *Resuscitation* 2001; **51**:113-22.
21. Kern KB, Hilwig RW, Berg RA, Sanders AB, Ewy GA. Importance of continuous chest compressions during cardiopulmonary resuscitation: improved outcome during a simulated single lay-rescuer scenario. *Circulation* 2002;**105**:645-9.
22. Handley AJ. Teaching hand placement for chest compression – a simpler technique. *Resuscitation* 2002;**53**:29-36.
23. Wik L, Hansen TB, Fylling F *et al*. Delaying defibrillation to give basic cardiopulmonary resuscitation to patients with out of hospital ventricular fibrillation. *JAMA* 2003;**289**:1389-95.
24. Jacobs IG, Finn JC, Oxer HF, Jelinek GA. CPR before defibrillation in out-of hospital cardiac arrest. A randomised trial. *Emerg Med Austral* 2005; **17**:39-45.
25. Berg R, Sanders A, Kern K *et al*. Adverse haemodynamic effects of interrupting chest compressions for rescue breathing during cardio-pulmonary resuscitation for ventricular fibrillation cardiac arrest. *Circulation* 2001;**104**:2465-70.
26. Aufterheide T, Sigurdsson G, Pirrallo R *et al*. Hyperventilation induced hypotension during cardiopulmonary resuscitation. *Circulation* 2004; **109**:1960-5.
27. Sanders AB, Kern KB, Berg RA, Hilwig RW, Heidenrich J, Ewy GA. Survival and neurologic outcome after cardiopulmonary resuscitation with four different chest compression-ventilation ratios. *Ann Emerg Med* 2002;**40**: 553-62.
28. Dorph E, Wik L, Stromme TA, Eriksen M, Steen PA. Oxygen delivery and return of spontaneous circulation with ventilation compression ratio 2:30 versus chest compressions only CPR in pigs. *Resuscitation* 2004;**60**:309-18.
29. Dorph E, Wik L, Stromme TA, Eriksen M, Steen PA. Quality of CPR with three different ventilation:compression ratios. *Resuscitation* 2003;**58**: 193-201.
30. Assad D, Chamberlain D, Colquhoun M *et al*. Randomised controlled trials of staged teaching for basic life support. 1.Skill acquisition at bronze stage. *Resuscitation* 2000;**45**:7-15.
31. Babbs CF, Kern KB. Optimum compression to ventilation ratios in CPR under realistic, practical conditions: a physiological and mathematical analysis. *Resuscitation* 2002;**54**:147-57.
32. Weisfeldt ML, Becker LB. Resuscitation after cardiac arrest. A 3-phase time sensitive model. *JAMA* 2002;**288**:3008-13.
33. Valenzuela TD, Kern KB, Clark LL *et al*. Interruptions of chest compressions during emergency medical systems resuscitation. *Circulation* 2005; **112**:1259-65.
34. van Alem AP, Sanou BT, Koster RW. Interruption of cardiopulmonary resuscitation with the use of the automated external defibrillator in out-of-hospital cardiac arrest. *Ann Emerg Med* 2003;**42**:449-57.
35. van Alem AP, Chapman FW, Lank P, Hart AAM, Koster RW. A prospective, randomized and blinded comparison of first shock success of monophasic and bi-phasic waveforms in out-of-hospital cardiac arrest. *Resuscitation* 2003;**58**:17-24.
36. Schneider T, Martens PR, Paschen H *et al*. Multi-center randomised control trial of 150 J biphasic shocks compared to 200-360J monophasic shocks in the resuscitation of out-of-hospital cardiac arrest victims. *Circulation* 2000;**102**:1780-7.
37. Scottish Intercollegiate Guidelines Network. http://www.sign.ac.uk/guidelines/fulltext/50/section6